The
University of New Mexico
Bulletin

PUBLIC WATER SUPPLIES *of* NEW MEXICO

by

JOHN D. CLARK
and
KENNETH F. PRIEST

LIBRARY
JUN 20 1932
UNIVERSITY OF TORONTO

THE UNIVERSITY OF NEW MEXICO BULLETIN
CHEMISTRY SERIES, VOLUME 2, No. 1, JUNE 1, 1932
WHOLE No. 215
Published Twice a Month by the University of New Mexico
Albuquerque, New Mexico
Entered as Second Class Matter, May 1, 1906 at the postoffice at Albuquerque, N. M.,
under Act of Congress of July 16, 1894

UNIVERSITY OF NEW MEXICO PRESS

Foreword

This bulletin was prepared for the purpose of supplying, to any interested person, accurate information concerning the public water supplies of New Mexico. Requests for information frequently come to the University, and this publication contains the data commonly desired.

The authors gratefully acknowledge financial assistance received from the town, or the water company, of each of the following localities, which partly defrayed traveling expenses incurred in making examinations and collecting samples: Albuquerque, Alamogordo, Carlsbad, Clovis, Farmington, Lovington, Raton, Santa Fe, and Valedon.

The Public Water Supplies of New Mexico

The water supplies described in this bulletin furnish water for nearly 370,000 persons, or about 87 per cent of the total population of New Mexico. About 30 per cent of these people receive water which comes from rivers, creeks, or mountain streams, while 70 per cent are supplied with water from wells. Throughout the state the only constituents of the waters, which have any considerable industrial significance, are the salts of those two metals whose salts cause water to be hard—calcium and magnesium. These are always present, though in varying quantities according to the source of the water, and, when in large amounts, are unpleasant when water is used for domestic purposes, and, as they form scale in boilers, are undesirable when the waters are used for the generation of steam. Hence, in some of the localities described, the water is softened. Other methods of water purification used in this state consist of straining, filtration, or chlorination.

While this bulletin is primarily concerned with the characteristics of the mineral content of the waters, a word about the bacterial content of the waters should not be left unsaid. In general, the waters of New Mexico have remarkably low contents of bacteria. When the deep wells, from which the larger number of communities secure their water, are properly constructed, the waters coming from them have been filtered through sand and gravel beds, thus the number of bacteria is usually very low, yet even with this general assurance of purity, all communities insist upon bacteriological examinations at least twice a year. These examinations having a bearing upon the spread of communicable disease are made at the State Public Health Laboratory, at no cost to the communities.

Distribution of population in State. The estimated population for the state of New Mexico for the year 1930 was 423,300. A glance at the accompanying map shows this population to be widely scattered over a large area. The largest city, Albuquerque, has approximately 26,000 citizens within the corporate limits. Other large cities, according to the 1930 census, are three in number: Santa Fe, Roswell, and Clovis. And as is shown in the following table, the size of the various other communities is not large:

Distribution of Population[1]

Albuquerque	26,000	North central
Santa Fe	11,000	North central
Roswell	11,000	Southeast
Clovis	8,000	East
Las Cruces	6,000	South
Raton	6,000	North
Gallup	6,000	Northwest
Las Vegas	5,000	Northeast
Tucumcari	4,200	East
Silver City	3,500	Southwest

Extent of the Use of Public Water. When the latest census returns were compiled, 11 per cent of the total population of the state lived in the three districts of Albuquerque, Santa Fe, and Roswell. Another 9 per cent of the population lived in the remaining cities as listed in the table. Thus it appears the public water supplies of ten towns furnish water for 20 per cent of the population of the entire state.

These supplies, however, serve more than the per cent indicated, for the outlying districts have the same source of supply as the populated center.

1. Albuquerque Chamber of Commerce, 1931.

The problem of giving a complete analytical report of all water consumed in the rural districts in the state is not answered in this bulletin.

FIGURE 1. *The Geographic Distribution of Surveys*

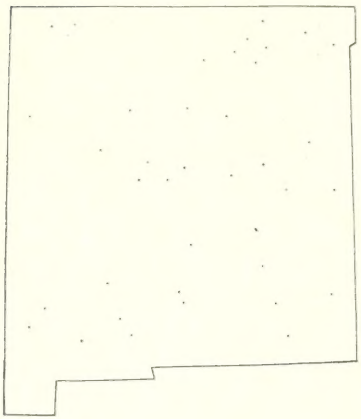
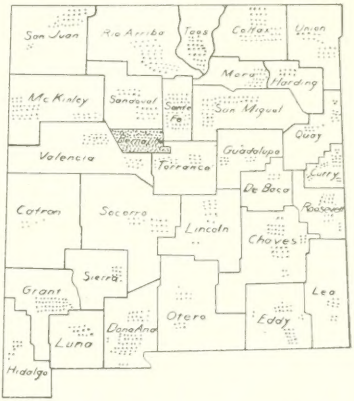


FIGURE 2. *Geographic Distribution of Population*



One Dot Represents 500

Mineral Constituents Determined and their Effects. In accordance with best practice, all samples taken for this study were analyzed for the following constituents, the results being stated in parts per million parts of water:

(a) silica
(b) iron and alumina
(c) calcium
(d) magnesium
(e) sodium and potassium
(f) carbonates
(g) bicarbonates
(h) nitrates
(i) sulfates
(j) chlorides

The effect upon water of each of the minerals is:

(a) *Silica:* This is an important compound in both hard and soft waters. When it occurs in large quantities it is especially deleterious and when precipitated, it forms a hard porcelain-like scale on tubes in boilers and on the sides of water mains. No special methods for its removal have been developed. It may be decreased, however, by filtration, or water softening. Settling also can diminish the silica content of water.[2]

According to Clarke,[3] "silica constitutes nearly 60 per cent of the lithosphere, so that the contact between water and silica is inevitable and its dispersion into particles of colloidal size takes place in every spring and stream."

(b) *Iron and Alumina:* Iron oxide, under certain conditions, may precipitate and leave its characteristic red stain. Alumina, an oxide of aluminum, is too little in quantity and too insignificant to warrant treatment.[4]

Hazen says, "It is well known that nearly all water attacks iron pipes, corroding them and forming tubercles on the inner surface. The rate at which this corrosion and tuberculation takes place depends entirely upon the constituency of the water. The process of forming tubercles is slow. Sometimes a year may elapse before a blemish one inch in height is formed. The process usually starts at a point where the iron is not coated. Organic material soon collects and carbonic acid is the result. The acid attacks the iron and forms ferrous carbonate. The compound mingles with the flowing water and by action of the iron present in the water, plus the oxygen, it is rendered into an insoluble ferric compound. This compound is precipitated and at the same time coagulation of the organic material takes place.

2. Allen Rogers, *Manual of Industrial Chemistry*, New York: Van Nostrand, Vol. I, Chap. II, 1926.
3. J. G. Vail, *Soluble Silicates in Industry*, New York: Chemistry Book Co., Chap. XVII, 1928.
4. Allen Rogers, Op. Cit., Chap. II.

This deposit is a firm, compact, but porous mass and is the beginning of a tubercle.[5]

"To remedy this situation, pipes may be coated with tar, cement, copper, and asphalt. Continuous flushing of mains will remedy, to some extent, this trouble."

Continuous formation of the oxide of iron in water systems may result in serious complaint from water consumers, as the iron-rich water will discolor white goods. Water from certain of the wells supplying Albuquerque was, at one time, so unsatisfactory that a treating system was installed to free the water from its iron content.

(c) *Calcium* and (d) *Magnesium:* Calcium and magnesium salts are widely distributed in nature. They are present, more or less, in all natural waters, giving to the waters the property known as hardness.

Calcium and magnesium form insoluble curd-like compounds with soap which cling to fabrics and interfere with washing. When water is heated, if either, or both, calcium or magnesium should be in solution as a bicarbonate, the calcium or magnesium precipitates as a carbonate. Calcium sulphate is much less soluble in warm water than in cold, and when water containing this salt is heated, a hard scale is certain to form. Chlorides of either element are given to hydrolysis when heated in water, liberating free hydrochloric acid. These facts show calcium and magnesium undesirable constituents of water. Their removal is ordinarily accomplished by water softening, combined with filtration.[6] Zeolite softeners are excellent for removing calcium and magnesium compounds from water, and are extensively used by laundries in this state.

(e) *Sodium and Potassium:* Sodium and potassium are present in nearly all natural waters. Since the compounds of these alkali metals are readily soluble, they are

5. Allen Hazen, *Clean Water and How to Get It*, New York: Wiley and Sons Chap. VI, 1916.
6. Allen Rogers, Op. Cit., Chap. II.

important to consider in waters of high mineral content. There are many boilers in use in this state, in which scale is not forming to any great extent, yet which should be "blown down" far more often than they are, so that fresh water of low sodium and potassium salt content can replace that which, through evaporation of steam, has become so rich in these salts that there is danger of foaming or priming. Fortunately, however, they are detrimental in but few cases. Water can be freed from sodium and potassium salts only by distillation.[7]

(f) *Carbonates* and (g) *Bicarbonates:* The quantity of these two radicles in hard water can be reduced by heating or by water softening. Treatment with strong acids is effective but is in use only in a few cases. Alkali carbonates in irrigation waters are sometimes rendered harmless by use of gypsum or "land plaster." The bicarbonate in moderate concentration is harmful in but few cases.[8]

(h) *Nitrates:* Nitrates are oxidizing agents and because of this they are undesirable in water used for many industrial processes. Fortunately they seldom occur in any considerable quantity and on account of their small concentrations they are usually ignored.[9]

(i) *Sulfates:* Sulfates are known to be derived chiefly from oxidation of sulfur or from solution from beds containing sulfates. They are most noteworthy in regions of sedimentary rocks and they are directly traceable to deposits from sea water. New Mexico contains billions of tons of gypsum which will at some future time be a considerable economic asset. In some localities water has had direct contact with gypsum beds and is thus high in "permanent hardness." Sulfates are injurious to boilers. The lime-soda treatment removes calcium from waters, however, leaving the sulfate ion in solution. Precipitation with barium carbonate can remove the sulfate ions, but water treated with barium carbonate should never

7-9. Allen Rogers, Op. Cit., Chap. II.

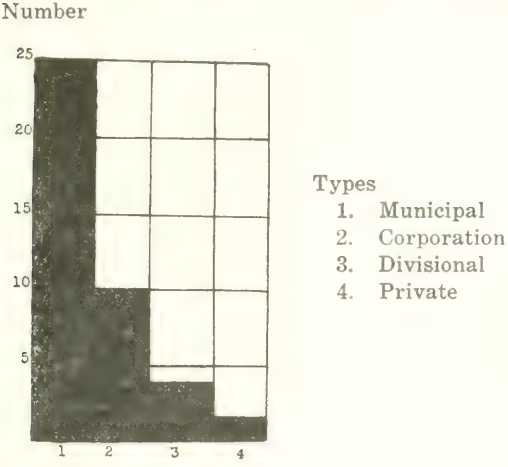
be used for domestic purposes. Barium salts are poisonous. Distillation may be used as an extreme remedy.[10]

(j) *Chlorides:* Chlorides are present in practically all waters and since the chlorides of bases found in water are very soluble, the chloride is a prominent constituent of nearly all waters of high mineral content. Chlorides in processes treating food stuffs or beverages tend to give a salty taste and excessive amounts must therefore be avoided.[11] Hydrolysis of the chlorides of calcium and magnesium, with production of free acid, has been mentioned. Chlorides can be effectively removed only by distillation.

Ownership of Systems

Municipal: Municipalities which own their water plants usually own the source of the water and the distribution system through which the water flows. Such

FIGURE 3. *Comparison of the Types of Ownership*



10-11. Allen Rogers, Op. Cit., Chap. II.

plants are operated by the municipality. Such systems are the most numerous in New Mexico.

Corporation: Corporations (other than municipalities) often own and operate the sources of water and the distribution systems in a community, operating under franchise.

Private: New Mexico has two privately owned water systems.

Divisional: In the divisional plan of ownership the municipal government buys the water but owns and operates the distribution system. These are few in number.

Source of Water Supplies and Impurities

Classification of Impurities: In general the impurities in water constitute four classes:

1. Dissolved gases such as oxygen, nitrogen, carbon dioxide, hydrogen, sulfide, etc.

2. Soluble crystalloids consisting of definite chemical compounds, which can be removed by precipitation and filtration.

3. Dispersed colloids consisting of material of very high molecular weight which will not settle or separate and can be filtered only after addition of coagulants.

4. Suspended matter which will settle or can be filtered.[12]

12. F. H. Thorp, *Outlines of Industrial Chemistry* (Third Edition), New York, Macmillan, Page 47, 1918.

Source of Supply in Relation to Impurities: That water is in a constant state of motion is a well known fact. It is likewise continuously passing through a cycle of evaporation and precipitation. Rain, hail, dew, snow, fog, or cloud, and sleet are forms of precipitation. Water, as in the form of dew, evaporates very rapidly. A certain amount of the water which falls as rain or snow evaporates more slowly, but a larger per cent of it runs into lakes or streams, or soaks directly into the ground. In passing over or through the soil, it is apparent that under ordinary conditions the water will dissolve the rocky materials. The more rapidly water passes over the land the less it will dissolve. According to Water Supply Paper 469,[13] "the surface water in a given area usually contains less dissolved mineral matter than the ground water." This is strikingly shown when the water from the Rio Grande is compared with that from wells in its valley, the latter always containing much more mineral matter.

The quality of water supplied to municipalities has, in recent years, become more and more closely scrutinized, because we have learned that in order to avoid ill-health our drinking water must meet certain standards of purity. No matter what the source may be, water generally contains varying amounts of foreign matter, which may be mineral or organic, either in suspension or in solution. These impurities can manifest themselves in color, odor, taste, or turbidity. Bacteria are revealed only upon laboratory examination.

The quality of water is a controlling factor in the location of industry. Knowledge of the character of available water is essential to a wise choice of location.[14] The industrial and domestic value of water depends upon its relative freedom from dissolved matter. Because of this property, pure water is unknown to nature. Even rain, the purest of natural waters, is contaminated by finely

13. W. D. Collins, *Industrial Utility of Public Water Supplies in the United States:* Water Supply paper No. 496; Washington D. C., U. S. Geological Survey, 1923.
14. Allen Rogers, Op. Cit., Chap. II.

divided mineral matter, particles of plants, ammonia, carbon dioxide, and other substances which the rain gathers in its fall through the atmosphere. Surface water is always more or less turbid, while ground water contains more of the dissolved mineral impurities, but whether passing over the surface, or slowly percolating underground, water takes into solution a part of the material with which it comes in contact.

Impurities derived from the air assist in the solution of rock-forming minerals, and then the dissolved materials exert an influence one upon another. The chemical constitution and physical condition of an area is therefore reflected by the water it furnishes.[15]

New Mexico, with its varying topography and its widely different geological horizons, has a wide variety of waters.

Surface waters: Creeks, rivers, and mountain streams furnish considerable water in New Mexico.

In the north central, and, to a slight degree, in the central portion, melted snow from the high mountains furnishes water almost throughout the year. Mountain springs are numerous, but in general they are too small to supply communities.

Generally speaking, the water from the rivers and creeks needs some form of treatment. This is especially true of Tularosa Creek and some parts of the Pecos River.

Surface water, as stated in Water Supply Paper No. 496,[16] probably furnishes the domestic supply of approximately one-half of the population which lives in the rural districts, and of a proportion of the 15 per cent which lives in cities of 2,500 to 25,000 inhabitants.

Underground Water: Underground waters from wells furnish approximately 70 per cent of the water in regions studied. The wells vary in depth from 20 to 900 feet. The water in most cases is pumped directly into a reservoir or

15. Allen Rogers, Op. Cit., Chap. 11.
16. W. D. Collins. *Industrial Utility of Public Water Supplies in the United States;* Water Supply Paper No. 496, Washington, D. C., Geological Survey, 1923.

standpipe. A "booster" pump is used in many cases to elevate water to a high level. Thus pressure is secured.

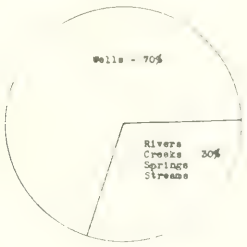
The limited quantity of water stored in the ground at most places, prevents a most general use of wells for public supplies. Heavy pumping lowers the water tables and increases the depth from which the water must be raised. This lowering of the water tables adds to the cost of operation and increases the chances of pollution.

Explanation of Impurities Shown by Analytical Report

The total dissolved solids in the public water of New Mexico vary from 76 to 1,144 parts per million.

The waters of three cities using well water, show total dissolved solids of 1,144, 1,135, and 1,072 parts per million respectively. The highest total dissolved solid content of river water is 1,112. In general the waters of southeastern and southwestern and southern portions of the state contain the greatest amounts of dissolved materials.

FIGURE 4. *Comparison of Sources*



Silica varies from 9 to 25 parts per million while the iron oxide with alumina range from 0.8 to 75 parts per million. Calcium varies from 15 to 269 parts per million

with magnesium running from 5 to 65 parts. Sodium and potassium range from traces up to 200 parts per million. The carbonate radicle is usually low, having a range from 9.6 to 73 parts per million, while the bicarbonate goes from 4.8 to 418 parts per million. Chlorides range from 12 to 280 parts per million. Nitrates appear only as traces in five samples of water which were analysed. Sulfate runs from 25 to 541 parts per million while the total hardness of water calculated as calcium carbonate, ranges from 75 to 791 parts per million.

Rainfall and Climate Data

Annual precipitation: The annual precipitation in New Mexico is shown statistically by the following table:[17]

Annual Precipitation
(1925-1930)

Year	*Average Annual*	*Snowfall*	*Average days with .01 or more*
1925	13.86	14.4	51
1926	17.44	35.3	65
1927	13.94	22.6	50
1928	15.09	30.1	54
1929	16.48	30.2	52
1930	14.64	26.0	53

The following table gives by counties, the annual precipitation in inches:[18]

17. C. E. Linney, *New Mexico Climatological Data*, Vol. 43, No. 13, p. 1, Santa Fe, 1930.
18. C. E. Linney, Garcia, Fabian, and Hollinger, E. C., *Climate as it Affects Crops and Ranges in New Mexico*, Bulletin 182, pp. 1, 79, State College, New Mexico, March, 1930.

Precipitation Table by Counties

County	*Average Annual Precipitation*
Bernalillo	8 in valley to 16 in mountains
Catron	13 in valley to 17 in mountains
Chaves	13.5 to 16
Colfax	14 to 18
Curry	16 to 19
De Baca	14 to 16
Dona Ana	8 to 10
Eddy	12 to 14-18 in mountains
Grant	9 to 12
Guadalupe	13.5 to 15
Harding	14 to 16
Hidalgo	9 to 12 to 16-18 in mountains
Lea	13 to 16
Lincoln	10 to 14, 16-18 in mountains
Luna	9 to 10
McKinley	11 to 14-16 in mountains
Mora	15 to 18-20 in mountains
Otero	9 to 12-15 or 20 in mountains
Quay	15 to 18
Rio Arriba	10 to 12-18 or 20 in mountains
Roosevelt	16 to 19
Sandoval	8 to 10, 18 or 20 in mountains
San Juan	6 to 9, 12 in upland
San Miguel	15 to 18, 25 in mountains
Santa Fe	10 to 14, 20 in mountains
Sierra	10 to 14-18 in mountains
Socorro	10 to 12
Taos	12 to 15-20 in mountains
Torrance	13 to 16-20 in mountains
Union	16 to 18
Valencia	8 to 12-16 in mountains

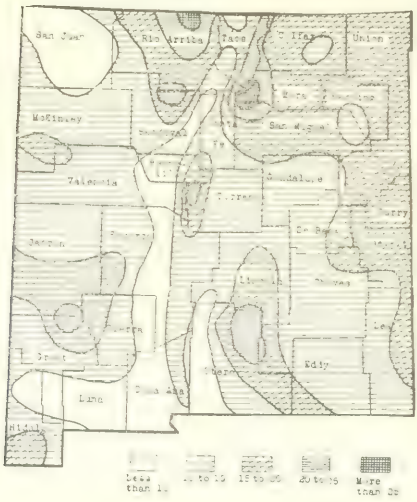
Rainfall summary: New Mexico is almost square in outline, being 350 miles from north to south and about the same from east to west. On account of its varied topography, the elevations range from about 3,000 feet in the southwestern corner, to about 14,000 at the top of the highest mountain. On the whole, New Mexico consists of high plateaus and mesas, with numerous mountain ranges, canyons, and valleys; some of the valleys are large enough to make possible the carrying on of extensive agricultural operations under irrigation.

Under ordinary conditions, the normal seasonal precipitation including the low mesas to the mountain regions, is from eight to twenty inches.

It is thought by people not familiar with the climate of New Mexico that tropical fruits are raised in this state. This is not the case; for, although New Mexico lies well to the south, the climate is not tropical on account of the high altitudes. A fig, which is a semi-tropical fruit, and which is grown as far north as latitude thirty-three degrees, principally in the lower Rio Grande and the Pecos valleys and the Tularosa Basin, is not produced successfully in the open or exposed field. The date palm, eucalyptus, and the California pepper tree are not hardy enough to withstand the winter temperatures of any part of the state.

In a general way, the lower valleys are dry (the precipitation averaging from six to ten inches annually), which means that agricultural undertakings are precarious without irrigation projects. Precipitation increases with altitude, and also somewhat from west to east; especially is the latter true east of the Rio Grande. The mountain areas,

FIGURE 5.
Map of Annual Precipitation



of which there are many, have much greater precipitation than the lowlands and valleys, and are thus the great natural reservoirs or storehouses of rain and snow, from which flow the streams that afford irrigation water for the valleys. In the mountains the precipitation increases rapidly with altitude, amounting to 18, 20, 25, or even 30 inches annually over the highest peaks.[19]

Seven Life Zones:[20] "New Mexico has an area of 122,034 square miles. The altitude ranges from 3,000 feet to 13,600. The annual precipitation varies from seven inches to thirty-five inches.

"This wide range in natural conditions makes possible a great diversity in plant and animal life. Anyone traveling from the northern to the southern part of the state could not fail to notice this marked diversity, particularly of the plant life. So uniform is plant and animal life in given areas that we have what are termed 'life zones.' There are seven life zones in North America; of these New Mexico has six—the only one not represented being the Tropical."

Processes of Treatment for Purification

Processes of purification: The employment of treatment for purification is not extensively used in New Mexico. The bacteria and turbidity treatment requiring a chlorine compound, is used to some extent. Filteration, in some form, is widely used, as is sedimentation. A baffle chamber, to insure proper settling of sand and debris is used in some cases. Copper sulfate in dilute solution is used by one system; while alum, a coagulant, is used by another.

The state is fortunate in having a wide range of water supply. Mountain streams and mountain springs which are filtered naturally by gravel and sand furnish a few

19. C. E. Linney, Garcia, Fabian, and E. C. Hollinger, *Climate as it Affects Crops and Ranges in New Mexico*, Bulletin 182, pp. 1, 79, State College, New Mexico, March, 1930.
20. E. F. Castetter, "Seven Life Zones," *New Mexico*, p. 4, April, 1930.

Six Life Zones in New Mexico

Zone	*Altitude (Ft.)*	*Precipitation (Annual)*	*Area of State*	*Characteristic Plants*	*Characteristic Animals*
Lower Sonoran	3,000- 4,000	8-10 inches	3/8	Mesquite, creosote, sotol, all-thorn, bunchgrass	Armadillo, antelope, diamond rattlesnake, Gila monster
Upper Sonoran	4,500- 7,500	10-15 inches	2/3	Junipers, pinions, oaks, yucca, cacti, shrubs	Mule deer, mountain sheep, prairie dogs, horned toad
Transition	7,500- 9,500	15-20 inches	1/12	Yellow pine, Gambel oak	Deer, bear, turkey, elk
Canadian	9,500-11,500	Unknown	1/66	Fir, pine, blue spruce	Bear, red squirrel, woodchuck
Hudsonian	11,500-12,500	20-25 inches	1/400	Englemann spruce, Siberian juniper	Sparrow, junco
Arctic-Alpine	12,500-13,000	Unknown	1/1200	Arctic-Alpine	Mountain sheep, weasel, red fox

communities. Numerous rivers and apparently an endless supply of underground or well water provide other centers of population.

The variation of sources gives rise to the range of impurities in waters which need purification before being used.

Chlorination: Chlorine processes of purification are used in New Mexico. Chlorination treatment may serve a double role, namely, to reduce bacteria count and to reduce certain mineral matter to a lower degree of concentration. A mixture of calcium hydroxide with bleaching powder can be made into a powerful water purifier, both lowering calcium bicarbonate and reducing the number of bacteria.

Cities using chlorination treatment to advantage are Clayton, Tularosa, Las Vegas, Farmington and Santa Rosa.

The strength of chlorine solutions for water treatment depends upon the conditions of the water.

Rogers states[21] the amount of hypochlorite necessary to affect sterilization depends upon the amount of oxidizable material present, the temperature, the allowable time of reaction, the period of storage and the turbidity of the water.

Chloride of lime, or bleaching powder treatment, as explained by Hooker,[22] is essentially simple, yet it requires able professional supervision. Several cases can be pointed out where much disappointment has resulted from haphazard work carried out or supervised by incompetent persons.

Hooker[23] adds that "chloride of lime is a most efficient deodorizer because upon coming in contact with any substance it destroys odors as well as bacteria."

Chlorination may be induced, according to Coffin,[24] by the following: (a) calcium hypochlorite; (b) sodium hypochlorite; (c) liquid chlorine.

21. Allen Rogers, *Manual of Industrial Chemistry*, Vol. I, Chap. II, New York, Van Nostrand, 1926.
22. A. H. Hooker, *Chloride of Lime in Sanitation*, p. 26, New York, Wiley and Sons, 1913.
23. Ibid., p. 26.
24. T. D. L. Coffin, *Chlorination the Water Supply of Greater New York*, Vol. LXXVI, New York, England News, 1913.

Coffin[25] states that, "The largest process of water sterilization is operated by Dunwoodie Chlorination Plant, capable of 400,000,000 gallons of water per day for New York City."

Allen Rogers[26] names ten distinct advantages of liquid chlorine over chloride of lime treatment. They are:

1. Greater efficiency and economy.
2. Liquid chlorine is a pure chemical.
3. A minimum space required for storage and operating.
4. Elimination of disagreeable odors and corrosive action in applying the disinfectant.
5. Liquid chlorine does not decompose.
6. Reactions simplified and more efficient at low temperatures.
7. A large overdose possible without producing tastes or odors in treated waters.
8. More accurate control of feed.
9. No lime salts are introduced into the water.
10. A large saving in labor.

Generally speaking, the number of water systems throughout the state using chlorination is small as is shown in the following table:

Percentage of Systems Using Chlorination

Systems using chlorination	20
Systems not using chlorination	80

Filtration: In general, underground water is filtered from the suspended matter by nature as the water passes through the soil. Little use is made of filtration processes for well water in New Mexico. If waters are stored in open reservoirs, the water may deteriorate in quality unless used in a short period of time, though if reservoirs or storage tanks are flushed occasionally, stored water will not become objectionable.

25. Ibid., p. 26.
26. Allen Rogers, Op. Cit., Chap. II.

The city of Roswell uses a sand and rock bed through which the water is allowed to pass. The bed is scrubbed or flushed from time to time to remove bacterial growth.

The city of Clovis passes the water through three settling chambers, and into a reservoir. Silica deposits itself in the filter. If this sand becomes too great in amount it is removed. The reservoir also has a small filter for the water to pass through on its way to the standpipe.

Portales uses a baffle arrangement and settling tank for removal of silica and insoluble matter.

Lovington employs a settling chamber which serves as a storage reservoir.

Tularosa uses a sand and gravel filter plus a series of settling tanks.

Silver City passes water from the source (if water shows insoluble matter) into a reservoir, thence through a sand filter from which it flows into the city mains.

Socorro uses a sand trap and screen for filtration.

Santa Rosa uses a baffle system filter.

Springer has a settling tank with a Permuda pressure system.

Albuquerque employs a sand filter as a part of its method of purification.

Straining: Straining is used by several systems when an open reservoir is employed. The material extracted usually consists of floating leaves, sticks, and other organic material. Examples of this method may be found in the cities of Alamogordo and Clayton. Straining is an old-time manner of extracting impurities from water. Hazen[27] states that "all the new types of water purification come from old methods. A great number of other processes have been proposed, and a few of them may be, in time, developed so as to be of some practical value. A long period of time passes before a new method or principle of treatment is

27. Allen Hazen, *Clean Water and How to Get It*, Chap. VI, New York, Wiley and Sons, 1916.

discovered, that is important enough to find a permanent place in the art."

Sedimentation: This process consists of taking water through tanks in which the velocity of the water is reduced and the heavier suspended materials are taken to the bottom by gravity. The accumulated sediment is removed when it becomes necessary. Sedimentation is widely used as a preliminary process and is the cheapest method of removing those large particles which will settle out in a short period of time.

Nearly all water will bring suspended silica into a water system. The degree of concentration depends considerably upon the source. Floods producing high water add to the troubles of reducing suspended silica. Undissolved materials will naturally settle if the water is allowed to stand. A tank or reservoir will, because of this, become a settling chamber. So that sedimentation may be hastened, Clayton and Albuquerque use sand to aid the process of sedimentation. A bed of sand will not only filter, but it will extract colors. Some systems find that an ordinary reservoir is sufficient to allow all undissolved matter to settle, thus rendering the water suitable for use.

Disinfection:[28] Chloride of lime or bleached powder and liquid chlorine are used to disinfect water. Springer uses copper sulfate as a disinfectant and algaecide. The strength of the solution used depends upon the organic content of the water. The solution acts to overcome and

28. Chlorination has become our most effective method of water sterilization. Formerly the treatment frequently caused complaint, because if water were over-treated there might remain in the water some taste of the chlorine. At the present time many communities in the world purposely over-chlorinate, thus rendering their water sterile beyond any question, and then by passing the water through beds of fine anthracite coal, they remove any excess of chlorine.

This fact is not generally known, but should be. for not only is over-chlorination a certain means of complete sterilization, not requiring expensive bacteriological control, but in New Mexico, finely divided, high grade anthracite can be obtained at an extremely low price, so that means of destroying excess chlorine are available to any community.

As an example of this property of anthracite duff, the following experiment of the senior author may be cited:

Anthracite duff wash washed with chlorine water and then held in contact with the chlorine water, which lost its chlorine, as follows: At the start 5 cubic centimeters of water contained 12.99 milligrams of chlorine, at the end of 15, 30, 45, and 60 minutes, the chlorine content was 5.59,1.12, 0.67, and 0.45 milligrams per 5 cubic centimeters.

rid the water of those bacteria and algae which cause objectionable odors and tastes, and those which are pathogenic.

Coagulation: Coagulation of suspended matter is made possible by use of alum. Raton uses this compound. After the alum treatment in the Raton system, the water is filtered to extract the impurities.

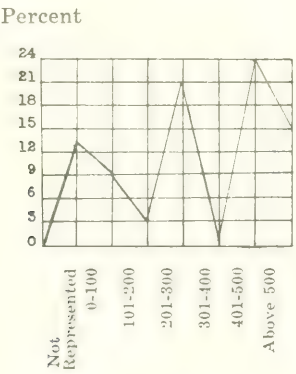
Analysis

Method of analysis: The system of analysis employed for this survey was adopted from the methods given in the U. S. Geological Survey Water Supply Paper 236.[29]

Summary of results: The total dissolved solid content ranges from 72 to 1,144 in parts per million.

The hardness of water varies from 72 to 791 parts per million.

The percentage of population as served by the various groupings of hard water classification is as follows:



29. R. B. Dole, *The Quality of Surface Waters in the United States*, U. S. Geol. Survey, Water Supply Paper 236, pp. 10-27, 1909.

Total dissolved solids: The results given under "Total Solids" show approximately the total quantity of mineral matter in each water analyzed. The quantity of total solids is determined by weighing the residue obtained by evaporating a given quantity of water. The weight of this residue after it has been heated one hour at a certain temperature is very nearly that of dissolved material.[30]

Hardness: Calcium and magnesium compounds dissolved in water cause hardness. The concentration of these dissolved salts gives the varying degrees of hardness.

Hardness is by far the most important property of a water with reference to its general industrial utility.[31]

According to Thorp,[32] "Temporary hardness is due to the presence of the bicarbonate radicle and the alkaline earth metals. The neutral carbonates are insoluble but dissolve in water containing free carbon dioxide. Permanent hardness is due to the presence of soluble neutral sulphates and chlorides of calcium and magnesium. Alkaline waters contain the sulfates, carbonates, or halogen salts of the alkaline metals in rather large amounts."

Ground waters are apt to be hard, that is to say, they contain large amounts of lime and magnesium in solution. In general, two conditions must be present to make ground waters hard. First, the material through which the water passes, or some of it, must contain the hardness-producing material, and, second, the condition must be favorable, chemically for dissolving it. The latter means that carbonic acid must be present[33] if the water is to have "temporary hardness."

The results given in this bulletin were obtained by calculation from the parts per million of calcium and magnesium. The hardness as equivalent calcium carbonate is 2.5 times the calcium, plus 4.1 times the magnesium.

30. Op. Cit., p. 5.
31. Ibid., p. 9.
32. F. H. Thorp, *Outlines of Industrial Chemistry*, Third Edition, p. 42, New York, Macmillan, 1918.
33. Allen Hazen, *Clean Water and How to Get It*, Chap. VI, New York, Wiley and Sons, 1916.

The hardness of water does not depend upon the amount of lime in the material through which it has passed, but upon the power of the water to dissolve the lime. The hardness of the water depends more upon the richness or fertility of the soil upon the catchment area than upon the amount of lime in the various material through which the water flows, provided, of course, that there is some substantial amount of lime to be taken up where conditions permit.[34]

The water softening process consists of adding chemicals to the water to precipitate its calcium and magnesium and filtration to affect a more complete clarification. Under present practice the entire softening process is often carried out almost automatically in specially constructed water softening machines. An analysis of the water to be treated indicates closely the quantity and kind of chemicals that should be added and the machine is adjusted to add them automatically.[35]

The Permutite zeolite water softening process is employed in a few cases in New Mexico. Zeolite is used extensively in the city of Gallup. The Permutite process employs an artificial sodium-silico aluminate to soften hard water. Water, in passing through the bed of zeolite, gives its calcium and magnesium to the zeolite, and takes sodium from the zeolite. In this manner the calcium or magnesium is removed. In time the zeolite will remove no more hardness and must be regenerated. Regeneration is affected by treating the zeolite with common brine. The sodium of the salt forces out the calcium and magnesium from the zeolite and the zeolite is restored to its former softening power. The salt solution is drawn off, removing the calcium and magnesium ions that were once in the hard water.[36] The only material consumed in this method is

34. Allen Hazen, *Clean Water and How to Get It*, Chap. VI., New York, Wiley and Sons, 1916.

35. Allen Rogers, *Manual of Industrial Chemistry*, Vol. I, Chap. II. New York, Van Nostrand, 1926.

36. C. W. Gray, Sandifur, C. W., and Hanna, H. J., *Fundamentals of Chemistry*, p. 341. New York, Houghton Mifflin Co., 1929.

salt, which is cheap. This method of water softening, requiring no analytical control, can be used to excellent advantage in New Mexico. Our waters do not have the same mineral content at all times. A lime-soda softener needs to have its charge varied to meet changes in the water. The zeolite needs no analytical management.

This table shows the treatment given water supplies in New Mexico. It does not include the industrial or business concerns which soften their water and, of course, does not include the small domestic softeners.

Municipal Water Softening

Systems employing a softening process	5%
Systems not employing a softening process	95%

Accuracy of analysis: The analyses were made by well established methods and the results have been examined carefully for indications of possible inaccuracies. There is little doubt of the accuracy of the analyses of the samples examined and, in general, the samples were as representative as any that could be obtained. The mineral content of the water of many municipal supplies can vary so much from day to day that in addition to an analysis giving average results, analyses giving maximum and minimum results are sometimes necessary to show the probable range in the quantities of the several constituents.[37]

General Survey of Hard Water in New Mexico.

The water from each section of the state contains various amounts of hardness. The southern and southeastern portions gave the highest degrees of hardness. Four cities in this section, Roswell, Artesia, Carlsbad, and Fort Sumner, all in the vicinity of the Pecos River, have re-

37. W. D. Collins, *Industrial Utility of Public Water Supplies in the United States*, U. S. Geol. Survey, Water Supply Paper 496, pp. 1-27, 1923.

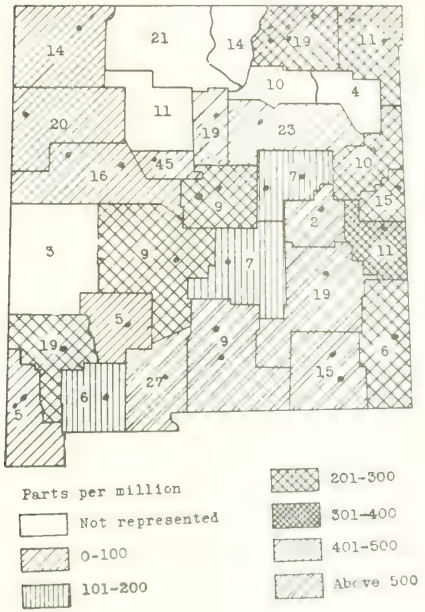
spectively 791, 557, 685, and 512 parts per million of hardness.

On the eastern side of the state from Union to Lea County the hardness did not vary to any considerable extent. The range covered from 221 to 344 parts per million.

The central part of the state ranged from 72 in Santa Fe County to 473 parts per million of hardness in Bernalillo County.

The western counties ranged in hardness from 282 to 462 parts per million.

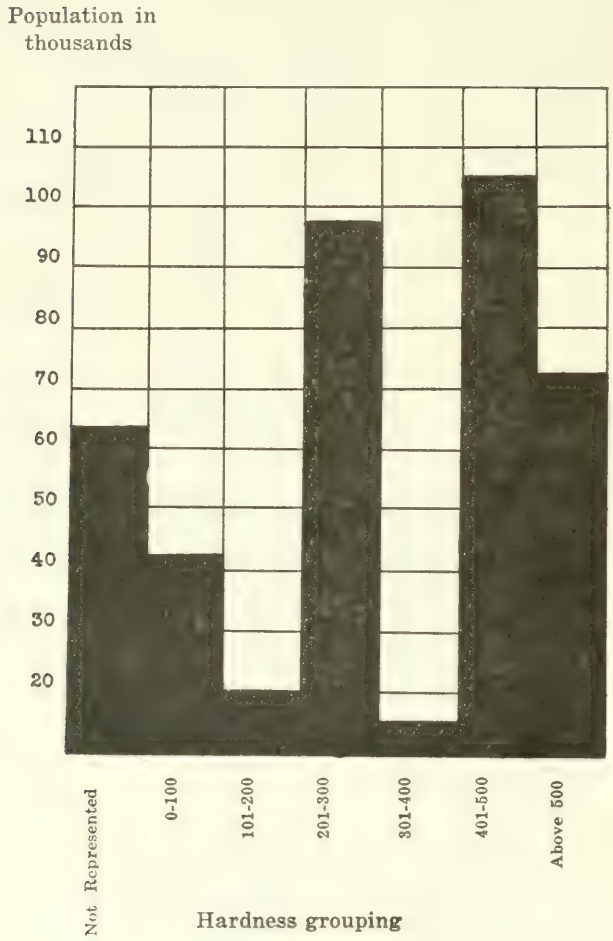
FIGURE 6. *Geographic Distribution of Hardness*



Dots show location of cities.

Figures show population of counties in thousands.

FIGURE 7. *Comparison of Number of Persons Using Water of Certain Degrees of Hardness*



Statistical Summary

Community	Standpipes—S Reservoir—R Capacity in Gals.	Treatment	Pressure in System	Depth of Source (Ft.)	Source of Supply	Ownership P—Private C—Corporation M—Municipal	Hardness as Calcium-Carbonate	Elevation
Alamogordo	R-500,000 R- 50,000	None	60		Creeks	M	317	4350
Albuquerque	R-(2) 5,000,000	Treated	90-120	60-700	Wells	M	473	5000
Artesia	S-100,000	None	60- 80	500-900	Wells	C	557	3300
Aztec	R- 50,000	None	75-100	14	Well	M	692	5600
Belen	S-500,000	None	30- 50	300	Wells	C & M	224	4800
Carlsbad	S-108,000	None	50- 70	180	Well	C	685	3100
Carrizozo	R- 35,000	None	50		Creeks	C	132	5400
Cimarron	R-100,000	None	67- 82		River	C	91	6427
Clayton	S- 75,000 R-100,000	Chlor.	60	86-400	Well and River	M	234	5280
Clovis	S-750,000	None	40- 58	300-600	Wells	C	221	4200
Dawson	R-	None	50- 75		Well and River	C	213	6630
Deming	S-175,000	None	20- 65	65	Wells	M	185	4300
Des Moines	R-	None	50	20- 30	Well	M	266	6622
Estancia	S-150,000	None	35- 65	52	Well	M	347	6020
Farmington	R-	Chlor.	60- 70	18- 25	Wells and River	M	175	5600
Fort Sumner	S- 35,000	None	35	25-200	Well	P	512	3960
Gallup	R- 20,000	Softening	70- 83	250	Wells	C & M	112	6500
Grants	S- 50,000	None	75	81	Well	P	700	6500
Hot Springs	S- 50,000 R- 50,000	None	75	20- 30	Wells	M	443	4200
Las Cruces	R-3,000,000 S- 80,000	None	60- 80	80-220	Wells	C & M	629	3850
Las Vegas	S-(2) 5,000,000	Chlor.	60- 80		River	C	78	6400
Lordsburg	S- 65,000	None	40- 60	175	Wells	M	81	4235
Lovington	S- 30,000	None	50	125	Wells	C	282	3900
Maxwell	R-100,000	None	40- 50		River	M	248	5700
Mountainair	S-	None	55	500	Well	M	76	6470
Portales	S- 58,000	None	40- 60	22-100	Wells	C & M	344	4000
Raton	R-(2) 1,500,000	Alum	80-105		River	M	66	6700
Roswell	R-(2) 500,000	None	50- 80	280-320	Wells	M	791	3770
Santa Fe	2-420 Acre Ft.	None	70- 80		Creeks	C	72	7000
Santa Rosa	R-	Chlor.	40- 50		River	M	134	4600
Silver City	R-250,000 R-500,000	None	60- 75	55-600	Wells and River	M	282	5900
Socorro	R-	None	32- 35		Springs	M	215	4701
Springer	75 Acre Ft.	Treated	40- 60		River	M	427	5800
Tucumcari	S-175,000 R-(2) 200,000	None	60	35-300	Well	M	260	4185
Tularosa	R-750,000	Chlor.	40- 60		Creeks	M	773	4500
Valedon	R- 60,000	None	50- 60	750-900	Mine	C	790	4000
Vaughn	S- 30,000	None	40- 50		Well and River	C & M	144	5952

*See appendix

Source of Samples

City	*Date Obtained*	*Sample Obtained From*
Alamogordo	May 22, 1931	Buick Garage
Albuquerque	June 6, 1931	Residence—209 S. Richmond
Artesia	May 22, 1931	Tommy's Sandwich Shop
Aztec	May 26, 1931	Calloway Service
Belen	May 24, 1931	Highway Filling Station
Carlsbad	May 28, 1931	Moody's Repair
Carrizozo	May 22, 1931	Highway Service
Cimarron	June 4, 1931	Canyon Lunch
Clayton	June 2, 1931	Phillips "66"
Clovis	June 2, 1931	High School Building
Dawson	June 4, 1931	Filling Station
Deming	May 23, 1931	Fire Hall
Des Moines	June 2, 1931	Des Moines Motor Co.
Estancia	May 30, 1931	Estancia Drug Co.
Farmington	May 26, 1931	El Navajo Filling Station
Fort Sumner	May 28, 1931	Melton's Garage
Gallup	May 26, 1931	City Hall
Grants	May 26, 1931	Red Ball Garage
Hot Springs	May 24, 1931	Butte Garage
Lac Cruces	May 23, 1931	Pump House
Las Vegas	May 27, 1931	Central Garage
Lordsburg	May 23, 1931	Pump House
Lovington	May 22, 1931	Gas Works
Maxwell	June 2, 1931	Flehr Filling Station
Mountainair	May 30, 1931	Mountainair Motor Co.
Portales	May 31, 1931	Court House
Raton	June 3, 1931	Central Garage
Roswell	May 21, 1931	Spark's Chevrolet Garage
Santa Fe	May 27, 1931	Koury's Super Service
Santa Rosa	May 28, 1931	Santa Rosa Drug Co.
Silver City	May 23, 1931	College Service
Socorro	May 24, 1931	Keith's Garage
Springer	June 6, 1931	Hunter's Service
Tucumcari	June 2, 1931	City Hall
Tularosa	May 22, 1931	City Garage
Valedon	July 6, 1931	Mine
Vaughn	May 28, 1931	Garage

Descriptive Summary

ALAMOGORDO: (2,950); El. 4,300; Municipal; no treatment except screening; mountain springs; reservoir.

ALBUQUERQUE: (26,000); El. 5,000; Municipal; iron removal, chlorination; wells; reservoirs.

ARTESIA: (2,600); El. 3,300; Municipal; no treatment; artesian wells; standpipe.

AZTEC: (1,000); El 5,600; Municipal; no treatment; shallow well; small standpipe.

BELEN: (2,100); El. 4,800; city buys water from company; no treatment; well; standpipe.

CARLSBAD: (4,000); El. 3,100; Southwestern Public Utility Co.; no treatment; improvements under consideration; wells; mineral springs in vicinity; standpipe.

CARRIZOZO: (1,100); El. 5,400; Southern Pacific; no treatment; Eagle and Bonita Creeks; reservoir.

CIMARRON: (690); El. 6,420; Private; Cimarron Water Co. (corp.); no treatment; mountain streams; reservoir.

CLAYTON: (2,500); El. 5,280; Municipal; infiltration system, chlorination; wells and creek; sediment chamber; standpipe.

CLOVIS: (8,000); El. 4,200; New Mexico Utilities Co.; no treatment; pumped from wells, supply and pressure ample; standpipe and reservoir.

CUBA: No system; well water.

DAWSON: (2,200); El. 6,630; Phelps-Dodge Corp.; no treatment; well and river; reservoir.

DEMING: (3,300); El. 4,300; Municipal; no treatment; wells; standpipe.

DES MOINES: (700); El. 6,622; Municipal; no treatment; well; reservoir.

ESTANCIA: (900); El. 6,090; Municipal; no treatment; well; standpipe.

FARMINGTON: (2,000); El. 5,300; Municipal; river water may be treated by process of chlorination; wells and Las Animas river; reservoir.

FORT SUMNER: (850); El. 3,960; Private; no treatment; wells; reservoir.

GALLUP: (5,000); El. 6,500; Southern Union Gas Co.; private supply, town owns distribution system; Zeolite softening process used; wells; reservoir.

GRANTS: (600); El. 6,5500; Privately owned; no treatment; well; reservoir.

HATCH: No system; two sources of supply in town.

HOT SPRINGS: (1,200); El. 4,200; Municipal; no treatment; shallow well; reservoirs.

LAS CRUCES: (7,000); El. 3,850; City buys water from Mesilla Valley Electric Co.; no treatment; pumped from wells; standpipe and reservoir.

LAS VEGAS: (9,000); El. 6,400; Agua Pura Co.; Chlorination treatment; Gallinas river; standpipe.

LORDSBURG: (2,050); El. 4,245; Municipal; no treatment; well; standpipe.

LOVINGTON: (2,000); El. 3,900; Pecos Valley Gas Co.; no treatment; well; reservoir and standpipe.

MAXWELL: (500); El. 5,5700; Municipal; no treatment; mountain streams; reservoir (filter box).

MOUNTAINAIR: (2,000); El. 6,470; Municipal; no treatment; wells.

PORTALES: (2,900); El. 4,000; Municipal, pumping apparatus owned and operated by New Mexico Utilities Co.; no treatment except baffle arrangement for sand removal; wells, supply and pressure ample; standpipe and settling reservoir.

RATON: (6,100); El. 6,700; Municipal; alum treatment; springs, sedimentation, filtration; reservoirs.

ROSWELL: (11,500); El. 3,700; Municipal; no treatment; artesian wells; reservoirs.

SANTA FE: (11,200); El. 7,000; corporation, New Mexico Power Co.; no treatment, large portion of water is melted snow; Santa Fe Creek; reservoir.

SANTA ROSA: (1,000); El. 4,600; Municipal; sedimentation and chlorination treatment; Pecos River; small reservoir.

SILVER CITY: (3,515); El. 5,00; Municipal; no treatment; well and spring; concrete reservoir used as sedimentation chamber when needed.

SOCORRO: (2,050); El. 4,700; Municipal; no treatment; hot springs; small reservoir; possible improvements in the future.

SPRINGER: (950); Municipal; pressure filter, chemically treated; river; reservoir.

TAOS: No system.

TUCUMCARI: (4,500); El. 4,180; Municipal; no treatment; wells; standpipe and reservoirs.

TULAROSA: (2,000); El. 4,500; Municipal; baffle sedimentation and chlorination treatment; Tularosa Creek; reservoir.

VALEDON: (1,000); El. 4,000; Corporation; no treatment; mine; reservoir.

VAUGHN: (1,200); El. 5,952; Railroad wells and Southern Pacific Pipeline; no treatment; standpipe.

CITY, WITH COUNTY AND THE HARDNESS OF WATER

City	*County*	*Hardness, as calcium carbonate, is calculated in parts per million*
Alamogordo	Otero	317
Albuquerque	Bernalillo	473*
Artesia	Eddy	557
Aztec	San Juan	692
Belen	Valencia	224
Carlsbad	Eddy	685
Carrizozo	Lincoln	132
Cimarron	Colfax	91
Clayton	Union	234
Clovis	Curry	221
Dawson	Colfax	213
Deming	Luna	185
Des Moines	Union	266
Estancia	Torrance	347
Farmington	San Juan	175
Fort Sumner	De Baca	512
Gallup	McKinley	412
Grants	Valencia	700
Hot Springs	Sierra	443
Las Cruces	Dona Ana	699
Las Vegas	San Miguel	78
Lordsburg	Hildalgo	81
Lovington	Lea	282
Maxwell	Colfax	248
Mountainair	Torrance	76
Portales	Roosevelt	344
Raton	Colfax	66
Roswell	Chaves	791
Santa Fe	Santa Fe	72
Santa Rosa	Guadalupe	134
Silver City	Grant	282
Socorro	Socorro	215
Springer	Colfax	427
Tucumcari	Quay	260
Tularosa	Otero	773
Valedon	Hidalgo	790
Vaughn	Guadalupe	144

*See appendix.

Analytical Tabulation

Analyses (parts per million)

	Total dissolved solids	Silica (SiO_2)	Iron (Fe_2O_3, Al_2O_3)	Calcium (Ca)	Magnesium (Mg)	Sodium and Potassium (Na and K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Chloride (Cl)	Nitrate (NO_3)	Sulphate (SO_4)	Total hardness as $CaCO_3$
Alamogordo	424	14.6	1.6	88.8	23.3	11	7.2	222	15		133	317
Albuquerque*	696	11.7	[illegible]	116.1	26.4	45.2	9.6	414.8	42		140.2	473
Artesia	840	35	3.6	146	47	36.5	73	151	32		441	557
Aztec	943	26	8.6	244.5	21.36	15.6	9.6	174.68	29		507.4	692
Belen	524	65.3	7.0	73	10	62	4.8	122.4	18		211.4	224
Carlsbad	1138	21.1	5.8	180	57.4	142	19.2	178.1	280		380	685
Carrizozo	226	15	34.7	37	8.7		9.6	21.9	25		77.7	132
Cimarron	128	11.4	6.6	18	11.3		12	13	17		51	91
Clayton	376	15.8	12.6	52	40	18	48	148.8	40		130.8	234
Clovis	258	29.6	0.9	41.7	28.7	20.2	14	205	34		23.1	221
Dawson	276	21.4	5.8	61	15	6	24	102	41		76.9	213
Deming	192	18.9	1.4	39.4	21.40	6.8	16.8	117	23		24.8	185
Des Moines	284	22.6	3.	41	40	6	12	204	14		76.3	266
Estancia	360	29.4	3.8	70	42	2	14.4	251	28		85.8	347
Farmington	257	29.4	6.8	42	17.2	11	9.6	68	23		101	175
Fort Sumner	726	35.8	0.8	116	54.2	50	19.2	148.8	110		292	512
Gallup	1030	34.2	31.4	56.8	65.9	200+	12	268	68	tr.	465.9	412
Grants	864	31.4	7	210	42.7	10.2	43	234	128		333.5	700
Hot Springs	524	29.6	1.4	149	17.2	57	38.4	39	22.8	tr.	201.4	443
Las Cruces	1020	56.5	33.9	175	64.4	70	28.8	241	216	tr.	311.8	699
Las Vegas	118	10.2	7	15	10	4.2	21.6	39	14		30	78
Lordsburg	410	55.2	5.8	7.7	14.9	115+	33.6	165.9	56		96.8	81
Lovington	372	42.6	2.3	80.3	20.3	9.2	28	102.4	71		98	282
Maxwell	314	23.6	7.4	59.5	24.6	6.2	24	136	26		102	248
Mountainair	268	34.4	.8	24.4	36	10	38.4	124.4	39		61.5	76
Portales	504	47.6	10.6	100.3	23.4	30	26	168	94		134	344
Raton	106	21.2	6	18	5			14.6	12		22.3	66
Roswell	1144	30	6.6	240	46.7	73	14.4	160	209	tr.	466.2	791
Santa Fe	76	10	2.6	15	9	tr.	21.6	41	12		22	72
Santa Rosa	230	28	6.2	38.8	9	12	21.6	31.7	45		65.9	134
Silver City	378	27.8	3	75	23	10	45.6	107	42		135	282
Socorro	318	33	20	42	27	12	21.6	85.4	38		102	215
Springer	609	50.6	8.2	112	36	20		175	32		256	427
Tucumcari	368	32	11.1	55.2	30	26	5.2	173	54		82	260
Tularosa	1112	49	75	252	35	10	40.8	40	116		541	773
Valedon	1072	65	33	269.9	28	8	19	132	100		504	790
Vaughn	210	9.4	1.3	38.3	12	6	16.8	4.8	24		108	144

Appendix

VARIETIES OF WATER ANALYSES, AND TAKING OF SAMPLES

This bulletin opened with a foreword in which the statement was made that there is a constant demand for data concerning what is already known of certain waters. The appendix also supplies frequently needed information, for often the only way by means of which one can secure information concerning some water is by taking a sample and having an analysis made.

There are three kinds of water analyses, commonly spoken of as the *bacteriological,* the *sanitary* and the *mineral* analyses.

The *bacteriological analysis* reveals the number, and (to some extent) the kind of bacteria present in water, the sample of which must be taken in a specially sterilized bottle, and sent to a laboratory in a special container, in which provision is made for refrigeration. As few persons possess the necessary technique for taking such a sample, the State Public Health Laboratory requires that such samples be taken by physicians or county health officers. Because bacteriological examination is in the interest of public health, the state makes no charge for bacteriological analysis. This is the only kind of water analysis made at the State Laboratory.

PUBLIC HEALTH

The *sanitary water analysis* reveals the amount, and (to some extent) the kind of organic matter in water. Samples should be taken only in specially prepared, glass stoppered, gallon bottles. This analysis is made less frequently than the other two.

The *mineral analysis* reveals the amount, and the nature of the dissolved mineral matter in the water. Samples should be taken in clean, glass containers, of one-gallon size. The container should be rinsed thoroughly with the water whose analysis is sought, and the rinsings discarded. The

REPRESENTATIVE BACTERIOLOGICAL ANALYSES OF MUNICIPAL WATER SUPPLIES, 1932

(Data furnished by the New Mexico Bureau of Public Health)

City	Bacteria per cc[1]	Gas		B. Coli[2] present		
		10cc	1cc	10cc	1cc	0.1cc
Alamogordo	15[2]	2/5	0/2	---	---	---
Albuquerque	10	1/5	0/2	---	---	---
Artesia	8	0/5	0/2	---	---	---
Aztec	8	3/5	0/2	---	---	---
Belen	50	0/5	0/2	---	---	---
Carlsbad	5	1/5	0/2	---	---	---
Carrizozo	75	3/5	0/2	---	---	---
Cimarron	10	1/5	0/2	---	---	---
Clayton	25	1/5	0/2	---	---	---
Clovis	12	0/5	0/2	---	---	---
Columbus	8	2/5	1/2	---	---	---
Dawson	100	3/5	1/2	---	---	---
Deming	20	1/5	0/2	---	---	---
Des Moines	40	2/5	0/2	---	---	---
Dexter	30	3/5	0/2	1/5	---	---
Estancia	100	3/5	0/2	---	---	---
Farmington	150	4/5	1/2	1/5	---	---
Fort Sumner	100	2/5	0/2	---	---	---
Gallup	75	0/5	0/2	---	---	---
Grants	40	1/5	0/2	---	---	---
Hagerman	75	3/5	1/2	1/5	---	---
Hobbs	150	3/5	1/2	1/5	---	---
Hot Springs	50	2/5	0/2	---	---	---
Hurley	5	1/5	0/2	---	---	---
Las Cruces	10	1/5	0/2	---	---	---
Las Vegas	15	0/5	0/2	---	---	---
Lordsburg	100	3/5	0/2	---	---	---
Lovington	150	1/5	0/2	---	---	---
Madrid	10	0/5	0/2	---	---	---
Magdalena	50	2/5	0/2	---	---	---
Maxwell	150	1/5	0/2	1/5	---	---
Melrose	20	1/5	0/2	---	---	---
Portales	20	1/5	0/2	---	---	---
Raton	10	0/5	0/2	---	---	---
Roswell	20	0/5	0/2	---	---	---
Santa Fe	5	2/5	0/2	---	---	---
Santa Rosa	150	5/5	1/2	1/5	---	---
Silver City	60	3/5	0/2	1/5	---	---
Socorro	10	1/5	0/2	---	---	---
Springer	300	4/5	1/2	---	---	---
Tererro	75	2/5	0/2	2/5	---	---
Tucumcari	25	0/5	0/2	---	---	---
Tularosa	100	4/5	1/2	---	---	---
Wagon Mound	25	3/5	0/2	---	---	---

1. Obtained by standard methods of water analysis as approved by the American Public Health Association.

2. The bacteria per cubic centimeter are, in no case, numerous enough to indicate serious pollution.

3. B. Coli is an organism normally found in the intestinal content of warm blooded animals. Its presence in a water indicates recent contamination. With one exception, all analyses listed here show that the waters meet the requirements of the U. S. Public Health Service, for interstate carriers.

mineral analysis is commonly made, and every commercial analytical laboratory is prepared to make reports on the mineral matter content of water.

While this bulletin was being printed, the city of Albuquerque, seeking to find softer water, drilled a new well which bids fair to furnish a very large volume of water.

The analysis of this water, in parts per million, is as follows:

NEW WELL—CITY OF ALBUQUERQUE

(Analysis by Harry Mauger)

Total solids	344
Silica	63
Iron and aluminum oxides	2
Calcium	28
Magnesium	25
Sodium and potassium	56
Chlorine	13
Sulfate (SO_4)	56
Carbonate (CO_3)	0
Bicarbonate (HCO_3)	205